CRASH DATA RESEARCH CENTER
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CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION

SCI CASE NO.: CA12030

VEHICLE: 2001 FORD ECONOLINE 350 / MEDTEC TYPE III AMBULANCE

LOCATION: PENNSYLVANIA

CRASH DATE: JUNE 2012

Contract No. DTNH22-07-C-00043

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract This on-site investigation focused on the crash of 2001 Ford Econoline 350 / Medtec Type III ambulance. The Ford was involved in a single-vehicle rollover crash during the return portion of a non-emergent, inter-facility patient transfer while traveling east on a four lane roadway. A restrained 55-year-old female driver and an unrestrained 22-year-old male front right passenger occupied the ambulance. The driver, who later stated that she had been fatigued, allowed the Ford to drift left from its travel lane and depart the east roadway edge. As the ambulance traversed up and along the roadside embankment, it struck a second sign as it initiated a rollover. The Ford completed a one-quarter turn, right side leading rollover as it fell off the embankment and reentered the roadway. During this sequence, the unrestrained front right passenger was partially ejected and his upper torso and head became physically pinned beneath the ambulance as it slid to final rest within the roadway. Both occupants were transported by ground ambulances to a local hospital, where the driver was treated for minor injuries and released. The front right passenger was pronounced deceased upon arrival at the emergency department of the hospital.			
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BACKGROUND

This on-site investigation focused on the crash of 2001 Ford Econoline 350 / Medtec Type III ambulance (**Figure 1**). The Ford was involved in a one-vehicle rollover crash during the return portion of a non-emergent, inter-facility patient transfer. The crash was identified through media reports by the Office of Emergency Medical Services (EMS) of the National Highway Traffic Safety Administration (NHTSA). The Office of EMS forwarded the notification to the Crash Investigation Division (CID), which then provided the notification to the Calspan Special Crash Investigations (SCI) team on June 4, 2012. The SCI team immediately contacted a representative of the state's Department of Health, who provided specifics of the location of the crash. Cooperation was then established with the towing agency in possession of the Ford on Tuesday, June 5, 2012 with arrangements to inspect the vehicle. The on-site portion of this investigation took place on June 6, 2012 and consisted of the detailed inspection and documentation of the Ford with specific focus on the sources of occupant injury. Additionally, the crash site was inspected and documented. Interviews were conducted with pertinent parties, including the emergency response personnel involved.

Figure 1: Damaged Ford ambulance being towed from the scene (*Image obtained from a local news source*).

The Ford ambulance was traveling south on a four lane roadway. A restrained 55-year-old female driver and an unrestrained 22-year-old male front right passenger occupied the ambulance. The driver, who later stated that she had been fatigued, allowed the Ford to drift left from its travel lane and depart the east roadway edge. Its undercarriage and frontal plane impacted a ditch and roadway sign before impacting and ramping up a roadside embankment. As the ambulance traversed up and along the roadside embankment, it struck a second sign as it initiated a rollover. The Ford completed a one-quarter turn, right side leading rollover as it fell off the embankment and reentered the roadway. During this sequence, the unrestrained front right passenger was partially ejected and his upper torso and head became physically pinned beneath the ambulance as it slid to final rest within the roadway. Both occupants were transported by ground ambulances to a local hospital, where the driver was treated for minor injuries and released. The front right passenger was pronounced deceased upon arrival at the emergency department of the hospital.

SUMMARY

Crash Site

The crash occurred on a four-lane roadway during morning hours. Weather conditions at the time of the crash were overcast skies with a temperature of 12.2 Celsius (54 Fahrenheit) degrees, 27.8 km/h (17.3 mph) westerly breeze, and 69% relative humidity. The roadway surface was dry bituminous (asphalt). All travel lanes were 3.7 m (12.1 ft) wide, delineated by single-dashed white lines. The northbound and southbound portions were not physically divided, but were separated by a double-solid yellow centerline. Supporting the travel lanes to the east and west were 1.6 m (5.2 ft) wide asphalt shoulders with rumble strips. Speed was regulated by a posted limit of 89 km/h (55 mph) in both directions.

Figure 2: Southbound trajectory view of the ambulance's pre-crash travel path.

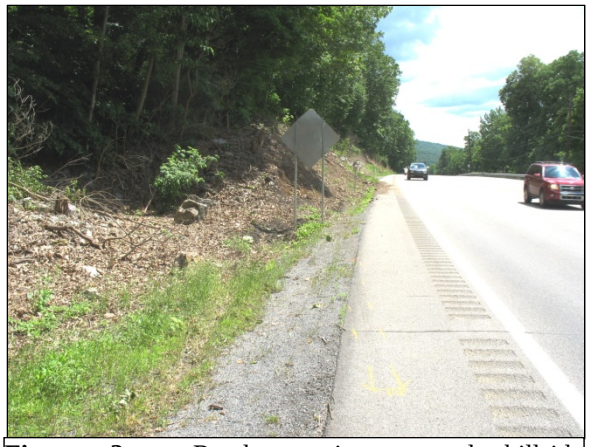

Figure 3: Roadway signage and hillside embankment on east roadside.

For the Ford ambulance's pre-crash travel trajectory, the roadway ascended a hillside with a slight right curvature (**Figure 2**). The slope of the grade was +3.5%, with a roadway superelevation of +2.8%. To the east, the roadway edge transitioned to a shallow ditch with roadside swale that ascended sharply up the hillside. The roadway began to achieve a natural crest, with the grade decreasing to +1%. Superelevation of the roadway within this vicinity was +3.1%. East of the road edge was a 1.5 m (5 ft) diamond-shaped sign for northbound traffic. This large sign was affixed to a pair of 5x5 cm (2x2 in) non-breakaway steel posts. Immediately east and south of this sign, the roadside swale transitioned sharply into a steep embankment with +75.7% grade that ascended toward the hilltop (**Figure 3**). This embankment paralleled the roadway south of the sign. A second 0.3 m (1 ft) square highway sign was located at the edge of the roadway, 13.9 m (45.5 ft) south of the large sign. A Crash Diagram is included on page 17 of this technical report.

Pre-Crash

After transporting a patient to a local hospital for treatment, the 55-year-old female and the 22-year-old male returned to the Ford ambulance. They loaded the Stryker® stretcher into the patient compartment of the ambulance and engaged the pin within the locking clamp mechanism, then closed the rear loading doors.

The female assumed position within the driver's seat, utilizing the available safety belt for manual restraint, while the 22-year-old male situated himself within the right front passenger's seat. He reclined the box-mounted seat's back until it engaged the bulkhead, then assumed a reclined position. The male EMS crewmember was not restrained. Both occupants were fatigued due to the early morning hours time of their initial response to the transport that they had just completed. It was now daylight, and as they began the approximate 20-minute trip back to their volunteer service's base of operations, the male fell asleep.

The female driver later reported that approximately 10-minutes into the journey, she began to feel the effects of her fatigue. She opened the left front glazing completely in an attempt to keep herself alert. Despite this action, she began to fall asleep as the ambulance ascended the hill while traveling south on the four lane roadway. The Ford began to drift left from its travel lane, then crossed over the centerline of the roadway. It traversed across both northbound lanes and entered the east (left) shoulder while both occupants slept.

Maintaining its errant trajectory in a tracking attitude, the ambulance's tires crossed over the rumble strips of the east shoulder as its frontal plane departed the roadway edge. The resulting vibration of the tires and wheels of the Ford on the rumble strips suddenly awakened the driver. After a brief delay in response as she identified the impending departure into the east roadside swale, the driver provided an abrupt braking and right steering input. Longitudinal skidding tire marks on the edge of the asphalt roadway and through the roadside swale evidenced the ambulance's trajectory (**Figure 4**).

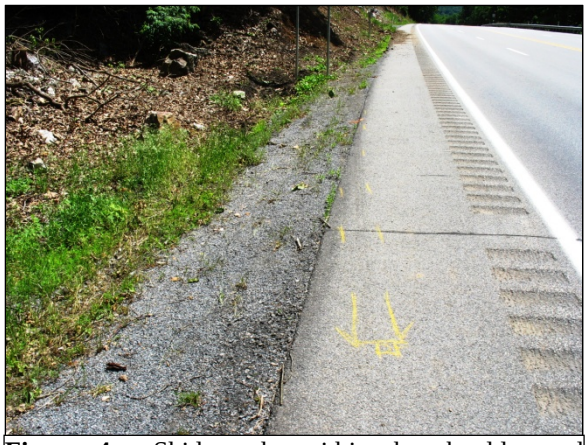

Figure 4: Skid marks within the shoulder and roadside swale evidenced the Ford's errant trajectory.

Crash

The first crash event occurred as the left front tire and wheel of the ambulance impacted the shallow ditch within the roadside swale. This impact was evidenced by the displacement of soil and rocks that occurred as the tire effectively furrowed through the earth surface, approximately 15 m (49.2 ft) south of its point of initial roadside departure. The forces associated with this impact were not of sufficient magnitude to alter the Ford's trajectory, and it maintained its forward movement.

The Ford's fontal plane then impacted the dual non-breakaway posts of the large roadway sign (Event 2), located approximately 25 m (82 ft) south of its point of initial roadside departure. This impact resulted in a pair of vertically-oriented damage patterns in the Ford's frontal plane, and both 5x5 cm (2x2 in) metallic stakes yielded immediately above ground level. The vehicle maintained forward movement, its trajectory unaffected by the yielding object impact.

Figure 5: Displaced soil, rock, and vegetation that evidenced the Ford's Event 3 impact and trajectory.

As the Ford progressed along the roadside, its frontal and undercarriage planes impacted the ground surface of the steep roadside embankment (Event 3) and it began to traverse up the steep incline. This impact was evidenced by the displacement of rock, soil, and vegetation (**Figure 5**). As the ambulance mounted the embankment and began to traverse its steep cross-slope, the vehicle initiated a counterclockwise (CCW) yaw. The Ford's right plane then impacted and overrode a small roadway sign (Event 4), located 38 m (124.7 ft) south of its point of initial roadside departure. The impact did not alter the ambulance's trajectory, and the sign's 5x5 cm (2x2 in) metallic stake yielded at ground level.

Figure 6: Look-back view of the ambulance's fall-over location and sliding trajectory.

An instability was created as the vertical axis of the Ford's center of gravity surpassed the vertical plane of its wheelbase while the vehicle traversed the steep cross-slope of the embankment. This initiated a flip-over rollover sequence as the ambulance rolled off the embankment (Event 5), right side-leading. The right plane of the Ford impacted the asphalt surface as the vehicle reentered the roadway, which disintegrated its right front glazing. The Ford maintained its trajectory as it slid across the northbound lanes, evidenced by gouges with metallic residue on the asphalt's coarse surface. Fluid spill discoloration on the roadway evidenced the ambulance's final rest position, which was located 65.5 m (215 ft) south of its initial roadside departure point. At rest, the vehicle was positioned on its right plane within the northbound lanes, facing southeast at an angle rotated 25 degrees CCW from its original heading angle. A look-back view of the ambulance's fall-over location and trajectory to final rest is depicted in **Figure 6**.

During the rollover, and in response to the lateral and non-horizontal forces, the unrestrained front right male occupant initiated an abrupt right lateral trajectory. His head and upper torso were partially ejected from the passenger compartment (cab) of the ambulance through the disintegrated right front glazing opening. The male's head and upper torso contacted the asphalt surface of the roadway. The partially ejected male ultimately became pinned between the right front door of the ambulance and the ground as the vehicle slid to final rest.

Post-Crash

The local emergency response system received multiple calls from passersby providing notification of the crash. Local law enforcement, fire department, and EMS personnel were dispatched to the scene. The ambulance agency's administration was also notified of the crash and several representatives responded to the scene. One of these passersby, whom was traveling northbound and witnessed the crash from a distance, stopped his vehicle to offer assistance. He reported locating the male front right passenger partially ejected, with his arms, upper torso, and head pinned beneath the right front door of the overturned vehicle. As this witness observed, the male was still conscious and making audible pleas for assistance.

Efforts were made by first arriving emergency response personnel to remove the front right passenger from beneath the vehicle. Due to the rapidly decreasing condition of the partially ejected male's vital signs and his loss of consciousness, personnel pulled the now unconscious male's body from beneath the overturned vehicle without physically or mechanically lifting it. Immediate emergency medical care was initiated in an attempt to resuscitate the front right passenger, and he was transported by a ground ambulance to a local hospital. Despite attempts to revive him, the male was pronounced deceased upon the arrival at the local hospital's emergency department. The Deputy Coroner's preliminary reported cause of death was positional asphyxiation.

The driver remained restrained within the overturned ambulance, in a partially suspended position. Emergency response personnel cut the webbing of the driver's safety belt system and assisted her from the vehicle. She denied injury, but was transported by a ground ambulance to a local hospital for precautionary evaluation. The ambulance was towed from the scene by a local recovery service to a local tow yard, where it was located for this SCI investigation.

2001 FORD ECONOLINE 350 / MEDTEC TYPE III AMBULANCE

Description

The 2001 Ford Econoline 350 chassis was manufactured in December 2000 and was identified by the Vehicle Identification Number (VIN): 1FDWE35F01Hxxxxxx. A placard confirmed that the incomplete vehicle chassis, equipped with the Ford ambulance preparation package, conformed to all applicable Federal Motor Vehicle Safety Standards (FMVSS) in effect as of its date of manufacture. The chassis was a 351 cm (138 in) wheelbase, rear-wheel drive platform powered by a 7.3 liter, V-8 diesel engine linked to a 5-speed automatic transmission. At the time of the SCI inspection (**Figure 7**), the vehicle's odometer reading was 112,179 km (69,705 miles).

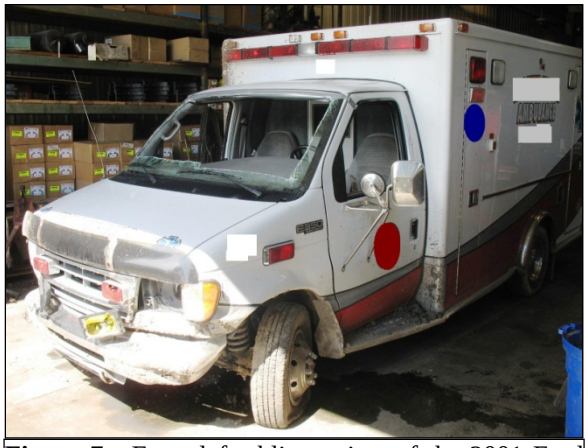

Figure 7: Front left oblique view of the 2001 Ford Econoline 350 / Medtec Type III ambulance.

The vehicle manufacturer's recommended tire size was LT225/75R16E, with recommended cold tire pressures of 448 kPa (65 PSI) front and 414 kPa (60 PSI) rear. At time of the SCI inspection, the vehicle was equipped with Firestone Transfore H/T tires for the front axle positions and Goodyear Wrangler H/T tires for the rear axle positions. All tires were of the recommended size, mounted on the OEM steel wheels. The Tire Identification Numbers (TINs) of the front and rear tires were all VN1L TWO and MK1L MMJV 1807, respectively. Specific tire data at the time of SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restriction	Damage
LF	Flat	8 mm (10/32 in)	No	Cut in sidewall
LR (outboard)	483 kPa (70 PSI)	5 mm (6/32 in)	No	None
LR (inboard)	469 kPa (68 PSI)	3 mm (4/32 in)	No	None
RR (inboard)	414 kPa (60 PSI)	5 mm (6/32 in)	No	None
RR (outboard)	379 kPa (55 PSI)	6 mm (7/32 in)	No	None
RF	Flat	9 mm (11/32 in)	No	Cut in sidewall

The interior of Ford's cab was configured for the seating of two occupants. Both were forward-facing box-mounted seats with manual seat track and seat back recline adjustments, and featured 3-point lap and shoulder safety belt systems for manual restraint. Head restraints were integrated into the seat backs. A frontal air bag system provided supplemental restraint. Between the two seats and beneath the instrument panel's stereo and climate controls was a center console with an array of switches and communications equipment related to the ambulance's emergency response and operations activities.

Medtec Type III Ambulance

The Ford chassis was completed as a Type III Certified "Star of Life" ambulance during secondary manufacturing by Medtec Ambulance Corporation in September 2001. This consisted of modifications to the existing van cutaway cab and the affixation to the chassis of the Medtec patient compartment module, as well as the installation of emergency services operational equipment such as warning lights, sirens, and radio communications. A placard confirmed that the Medtec Type III ambulance conformed to Federal Specifications KKK-A-1822 in effect on its date of manufacture. This refers to the United States General Services Administration's (GSA) standard for minimum specifications, test parameters, and criteria for design, performance, equipment, and appearance of ambulances in order to display the six-pointed blue star with Rod of Asclepius (Star of Life).

Patient Compartment Module

The Medtec patient compartment module had overall exterior dimensions (length x width x height) of 366 x 231 x 208 cm (144 x 91 x 82 in). There were five exterior compartments (two on the left plane, three on the right) that served for the storage of oversized and specialty items related to the ambulance's operation, roadside safety/vehicle equipment, and patient care.

Doublewide rear doors served for the loading and unloading of the stretcher, as well as entry/exit for the crew (**Figure 8**). There was also an occupant access door at the forward aspect of the right side. The interior of the patient compartment module served as a mobile emergency room for the treatment of emergent medical conditions in a pre-hospital environment. It was configured for the seating of up to five crewmembers surrounding a centralized stretcher for the patient, with numerous wall-mounted cabinets, shelves, and countertops for the storage of medical equipment and supplies.

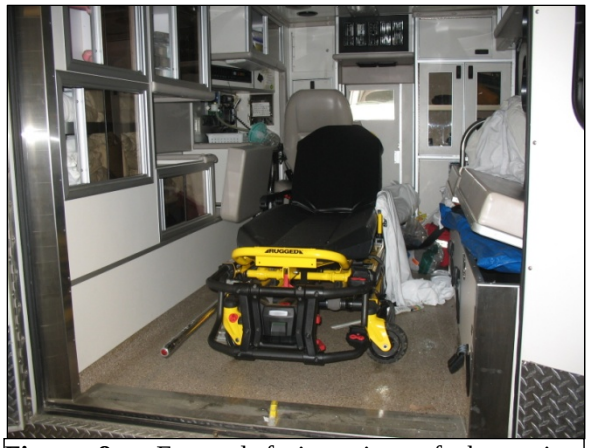

Figure 8: Forward facing view of the patient compartment of the Medtec ambulance module.

The patient compartment module's frame was constructed of 5x5 cm (2x2 in) square aluminum stock aligned in a ladder-frame pattern. All joints along the sill and roof side rail were welded and covered with 0.6 cm (0.25 in) aluminum fascia. The exterior surfaces were 0.3 cm (0.125 in) aluminum sheeting that was tack-welded to the frame. Interior surfaces of the patient compartment module were covered with 0.6 cm (0.25 in) painted plywood. The assorted interior cabinetry was constructed of 1 cm (0.375 in) plywood with 0.6 cm (0.25 in) painted plywood fascia and aluminum trim. Cabinetry doors were of various construction, including 1 cm (0.375 in) plywood with 0.3 cm (0.125 in) clear polymer inlays, 0.6 cm (0.25 in) clear polymer sliding doors inset within aluminum frames, and 0.6 cm (0.25 in) clear polymer panels affixed to pneumatic cylinders.

On the left side of the patient compartment were five storage cabinets and two countertops, with an integrated seating position. The forward aspect, adjacent to the bulkhead, consisted of a large countertop, a switch panel with lighting and climate controls, wall-mounted radio communications equipment, and a large storage cabinet near the ceiling. Aft of the large countertop was the "CPR seat", a position so-named as its location within the chest area of the patient (with respect to the stretcher) placed its occupant in an optimal location to perform cardiopulmonary resuscitation (CPR) on the patient if needed. The seat consisted of two cushions integrated into the wall-mounted cabinetry, with a wall-mounted lap belt available for the manual restraint of its occupant.

At the forward aspect of the ambulance was a stack of storage cabinets, the cab/module pass-through, and the "Captain's Chair". The Captain's Chair provided seating for one occupant, and was so-named as its location near the communications equipment, the module's lighting and climate controls, and its proximity to the cab with rear-facing overview of the stretcher was frequently the location of the occupant providing administrative leadership for the crew. It also placed its occupant at the head position of the patient, and was the prime location for performing airway management on a patient.

The Captain's Chair was equipped with a lap belt for manual restraint, with a folding armrest on the inboard aspect of the seat back. Behind the Captain's Chair, the heating, ventilation, and air-conditioning (HVAC) system was integrated into the bulkhead. Immediately inboard of the Captain's Chair seat back was a pass-through to the cab, which enabled visual and verbal communication between the driver and crew. Adjacent to the right wall was a stack of four cabinets for the storage of medical equipment bags and miscellaneous supplies.

The right occupant access door occupied the forward aspect of the right plane, adjacent to the bulkhead's stack of storage cabinets. Next to the door opening was a tubular handrail that contained the refuse bin and biohazard sharp objects container. This separated the door opening from the three-passenger bench seat affixed above the right rear axle position. The bench seat consisted of two folding cushions and was equipped with wall-mounted lap belts for manual restraint. The central area of the patient compartment module remained open and served as the location of the patient stretcher. Affixed to the floor was a forward antler bracket and a rear locking clamp mechanism to secure the stretcher in place.

Vehicle Weight/Payload

A placard on the Ford chassis declared a Gross Vehicle Weight Rating (GVWR) of 4,853 kg (10,700 lb). This was distributed as Gross Axle Weight Ratings (GAWR) of 2,086 kg (4,600 lb) front and 3,401 kg (7,500 lb) rear. A vehicle weight/payload certification sticker was affixed to the interior surface of the exterior storage compartment's door that was located at the forward aspect of the ambulance's left plane. Placarded by the manufacturer of the Medtec ambulance module, it declared that the curb weight of the overall vehicle after secondary manufacturing was 4,078 kg (8,990 lb). The curb weight at the axle locations was 1,651 kg (3,640 lb) front and 2,427 kg (5,350 lb) rear.

At the ambulance's date of manufacture, the minimum available payload allowed by the KKK-A-1822 specifications was 794 kg (1,750 lb). According to the vehicle's placard, the calculated actual payload of the completed vehicle was 776 kg (1,710 lb). Based on the SCI Investigator's experience and knowledge of EMS equipment and typical ambulance configuration, the estimated combined weight of the EMS equipment and supplies on-board the involved ambulance at the time of the crash was a minimum of 408 kg (900 lb). Using interview information, the combined weight of the two occupants of the ambulance at the time of the crash was calculated to be no more than 227 kg (500 lb). Based on those calculations and the vehicle's placards, it was concluded that the laden ambulance was not operating in excess of its available payload capacity at the time of the crash.

Exterior Damage

Damage to the exterior of the ambulance from the multiple-event crash was present on the frontal, undercarriage, and right planes of the vehicle. Event 1 damage involved the rearward displacement of the left front axle position, deflation of the left front tire, and the separation of left front suspension components.

No residual crush profile could be documented due to the location and involvement of the damage pattern. The Collision Deformation Classification (CDC) assigned to the Event 1 damage pattern was 12FLWN03. No WinSMASH calculations could be performed because the non-horizontal nature of the impact forces did not fall within the scope of the model's parameters.

A pattern of two vertically-oriented direct contact damage patterns resultant from the Event 2 impact with the highway sign were located on the Ford's frontal plane. This included minor bumper deformation, vertical abrasions, the disintegration of both fog light assemblies, and the fracture of the leading aspect of the fiberglass hood and polymer air deflector. Direct damage began 54 cm (21.3 in) left of center and extended 103 cm (40.6 in) laterally to 49 cm (19.3 in) right of center (**Figure 9**). A residual crush profile was obtained of the Ford's frontal plane, using a Field-L width of 168 cm (66.1 in) from bumper corner to bumper corner. The crush profile produced the following measurements: C1 = 0 cm (0 in), C2 = 2 cm (0.8 in), C3 = 0 cm (0 in), C4 = 0 cm (0 in), C5 = 2 cm (0.8 in), and C6 = 0 cm (0 in). Maximum crush for the Event 2 damage pattern was located at both C2 and C5. The CDC assigned to the ambulance was 12FDEW1. No WinSMASH calculations could be performed because the non-breakaway posts of the sign yielded during the impact engagement, which exceeded the scope of model's parameters.

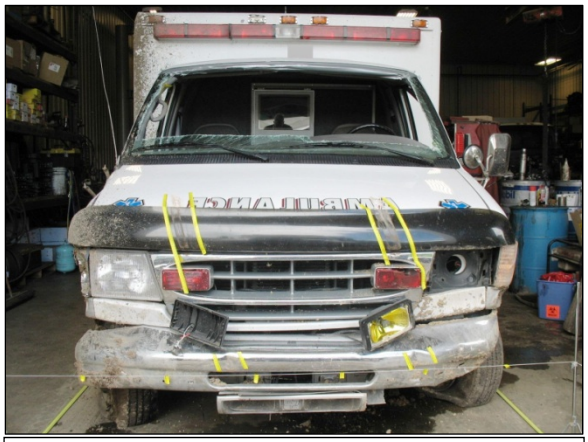

Figure 9: Overhead view of the severe frontal plane damage to the Ford/Medix Type II ambulance.

Direct and induced contact damage associated with the embankment (Event 3) impact spanned the Ford's entire 174 cm (68.5 in) frontal width. The damage pattern consisted of longitudinal and vertical bumper deformation, with the fracture of the polymer shroud encasing an emergency siren speaker mounted beneath the bumper. There was also noticeable induced deflection of surrounding frontal components. A residual crush profile documented at bumper level produced the following measurements: C1 = 9 cm (3.5 in), C2 = 1 cm (0.4 in), C3 – C5 = 0 cm (0 in), and C6 = 1 cm (0.4 in). Maximum crush for the Event 3 damage pattern was located at C1. The CDC assigned to the ambulance was 00FDLW1. No WinSMASH calculations were performed because the non-horizontal nature of the impact forces did not fall within the scope of the model's parameters. The exact location of direct and induced damage on the right plane of the ambulance related to the Event 4 impact with the small non-breakaway sign could not be determined due to the overlapping damage associated with the Event 5 rollover. Accordingly, the CDC assigned to the ambulance for the Event 4 damage was 99R99999. No WinSMASH calculations could be performed due to the unknown severity of the damage and lack of applicable measurements.

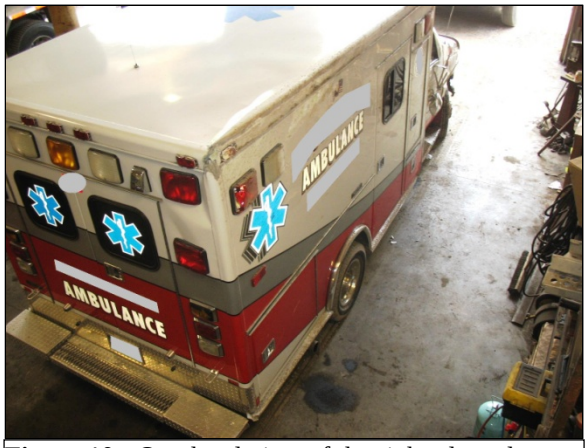

Figure 10: Overhead view of the right plane damage and right roof side rail buckling sustained by the Ford/Medtec Type III ambulance.

Right plane damage associated with the rollover sequence (Event 5) consisted of minor body surface deformation and abrasions (**Figure 10**). This included an area of buckling along the right roof side rail of the patient compartment module, predominant at the rear aspect. Multiple lens covers of side warning and marker lights were fractured or disintegrated. The right side mirror had separated from three of its four mounting locations and dangled precariously from the right front door. Maximum lateral deformation to the Ford's cab was present on the front fender, above the right front axle, and measured 7 cm (2.8 in) in magnitude. The maximum deformation sustained by the patient compartment was 5 cm (2 in) lateral deformation at the upper rear corner of the right plane, along the right roof side rail. No vertical crush was associated with the minor severity, one quarter-turn rollover event. The CDC assigned to the ambulance for the rollover (Event 5) damage pattern was 00RDAO2. Due to the non-horizontal nature of the rollover forces, no WinSMASH calculations could be computed.

Event Data Recorder

The Ford chassis was equipped with an Air bag Control Module (ACM) mounted to the floor beneath the cowl that had EDR capabilities. At the time of the completion of the field work, the current software version (5.0.2) of the Bosch Crash Data Retrieval (CDR) Tool did not support the Ford's 2001 model year. As such, the EDR could not be imaged for this SCI investigation.

Interior Damage

The interior of the Ford chassis' cab was inspected for crash related and occupant contact damage. Damage to the ambulance's interior was attributed to occupant contact, passenger compartment integrity loss, and displaced cargo/components. There was no measureable intrusion into the passenger area of the cab or patient compartment. Within the patient compartment of the ambulance, interior damage was attributed to displaced unsecured cargo contact. There was no intrusion into the patient compartment of the ambulance as a result of the multiple event crash, nor did it sustain integrity loss. Contact damage attributable to the front right occupant is depicted in **Figure 11**.

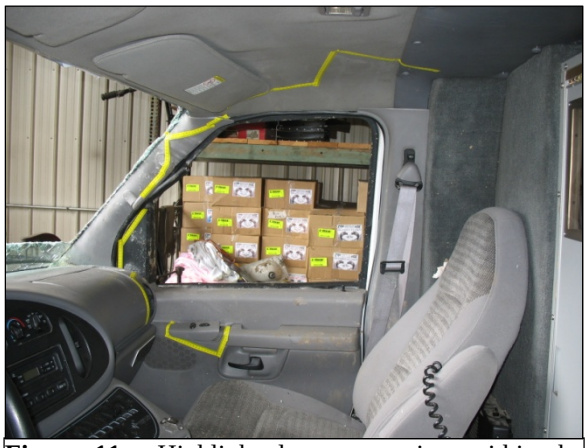

Figure 11: Highlighted contact points within the Ford's cab attributable to the unrestrained front right occupant's kinematics.

Occupant contact points within the cab were located on components surrounding the front right occupant, attributable to the unrestrained front right occupant's kinematics. These included scuffs and deformities to the upper right A-pillar, right roof side rail, headliner, right upper instrument panel, forward upper door quadrant, and right upper A-pillar grab handle. There was also blood and body tissue on the right upper A-pillar and the exterior surface of the right front door.

The Ford's AS1 laminated windshield was fractured and the AS2 tempered right front glazing was disintegrated during the crash. Post-crash, the windshield was removed by emergency response personnel to facilitate in the egress of the Ford's occupants. The fully-opened left front glazing was not damaged. The remaining AS2 tempered/original tint glazing of the right side and rear-loading doors remained intact and was not damaged during the crash. All doors remained closed and were operational post-crash, inclusive of all exterior storage compartment doors of the patient compartment module.

Manual Restraint Systems

The Ford's cab was equipped with 3-point lap and shoulder safety belt systems for manual restraint at both seating positions. Each consisted of continuous loop webbing with a sliding latch plate, and were height adjustable at their respective D-ring anchor position. The driver's safety belt retracted onto an Emergency Locking Retractor (ELR), while the front right passenger's safety belt retracted onto an ELR/Automatic Locking Retractor (ALR). The Ford was also equipped with front safety belt buckle pretensioners. The interior of the patient compartment module of the Medtec ambulance was equipped with manual lap belt systems at all four seating positions. All manual restraint systems within the patient compartment utilized continuous loop webbing and retracted onto ELRs mounted to the patient compartment walls.

At the time of the SCI inspection, the driver's safety belt webbing was cut 50 cm (19.7 in) above the lower anchor location. The latch plate remained engaged within the buckle, with the cut portion of the webbing having retracted onto the ALR retractor. The D-ring was adjusted fully upward. This evidence confirmed belt usage by the driver at the time of the crash. The front right safety belt system was loosely retracted against the right B-pillar, with the D-ring adjusted to its full-up position. There was no evidence on the front right safety belt system indicative of its use at the time of the crash. Depicted in **Figure 12** is a cut portion of the driver's safety belt system and the latch plate, which was still engaged within the buckle at the time of the SCI inspection.

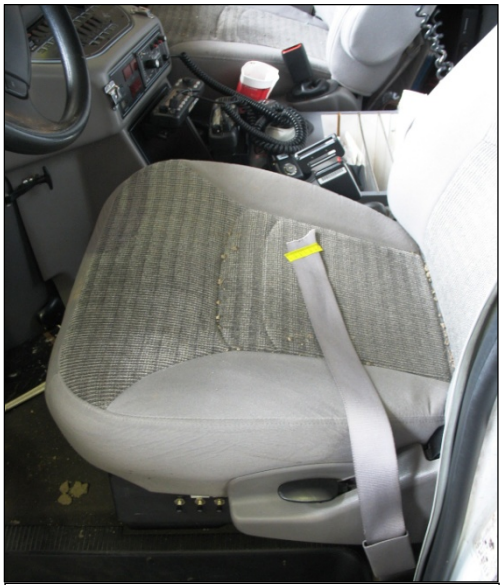

Figure 12: Cut portion of the driver's safety belt webbing and buckled latch plate.

Supplemental Restraint Systems

The cab of the Ford chassis was equipped with a frontal air bag system for supplemental restraint. This system consisted of single-stage air bags available for the driver and front right passenger, mounted within the steering wheel hub and top instrument panel. Both air bags were installed by the original manufacturer and had not required any service/maintenance prior to the crash. Neither air bag deployed in the subject crash.

Patient Stretcher

The patient stretcher was a 6500 Power-PRO XT Power Ambulance Cot, an exemplar of which is depicted in **Figure 13**. It was manufactured by Stryker, serial number (S/N): 110841469. Based on this serial number, it was manufactured in November of 2008 and was constructed of a tubular aluminum frame with circumferential weld joints and steel hardware fasteners. The X-frame supporting the mattress platform featured power raise/lower capabilities with infinite height positions between a minimum of 36 cm (14 in) and a maximum of 105 cm (41.5 in). The mattress platform featured 0-73 degrees of positive backrest angular adjustment via a manually controlled gas-pressure cylinder. In a similar fashion, the leg portion featured 15 degrees of positive angular adjustment. Overall dimensions of the stretcher were 58 cm (23 in) wide and 206 cm (81 in) long, and its unladen weight was 57 kg (125 lb). A placard declared that the load capacity limit of the stretcher was 318 kg (700 lb).

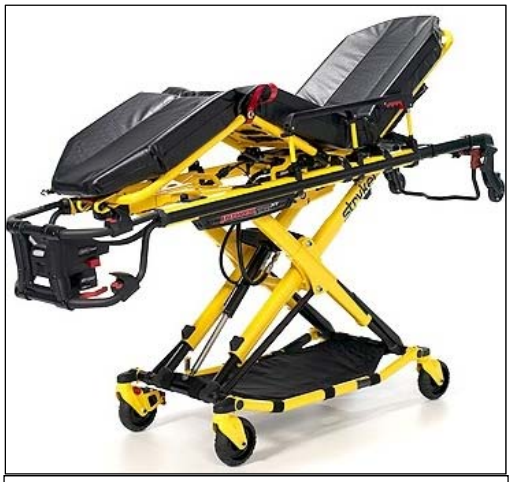

Figure 13: An exemplar Stryker Power-PRO XT stretcher.

Electrical power for the raise/lower capability was supplied by a removable 24-volt nickel-cadmium (NiCad) direct current battery pack, manufactured by DeWalt. When depleted, the battery was removed from its port and placed in a docking station for automatic charging via a 120 / 220-volt alternating current connection. The Stryker stretcher was equipped with a multi-strap system for manual restraint of its occupant (patient). This multi-strap system included lateral leg, lap, and chest straps that utilized continuous loop safety belt webbing with locking latch plates. It did not include shoulder straps.

Stretcher Anchoring System

The stretcher was secured in place within the patient compartment module via a Ferno-Washington, Inc. Model 175-2 Cot Fastener System. It was manufactured during year 2008, as identified by the manufacturer's S/N: 08-076264. The system consisted of a forward antler bracket and rearward locking-clamp mechanism. The antler bracket cradled the forward portion (location of the patient's head area) of the stretcher's frame, while the vertically oriented locking mechanism clamped around a pin protruding from the stretcher's lower frame rail. Combined, these two components restricted the lateral and longitudinal movement of the stretcher.

Stretcher and Stretcher Anchoring System Damage

During the rollover crash event, lateral crash forces induced a right lateral trajectory to the stretcher (with respect to the patient compartment's floor). The mass of the stretcher, coupled with the associated lateral crash forces, translated through the locking pin and frame to the locking-clamp mechanism and antler bracket. The stretcher's forward frame and guide wheels loaded the antler bracket, which restricted the lateral movement of the stretcher. This created a negative moment of inertia to the stretcher, which translated lateral forces on the locking clamp. The magnitude of the resultant forces exceeded the load capacity of the anchor bolts and subfloor securing the clamp to the patient compartment's floor, and the clamp deformed right laterally. In such a manner, the stretcher moved laterally 8 cm (3.1 in), but did not disengage from the locking clamp. This movement is depicted in **Figures 14 and 15**. The stretcher itself did not sustain any apparent damage during the crash sequence. All adjustments and mechanical components functioned within their intended limits.

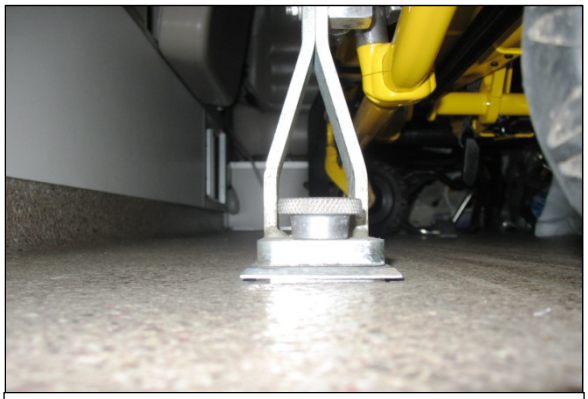

Figure 14: Orientation of the Ford's locking clamp mechanism when moved to its original position.

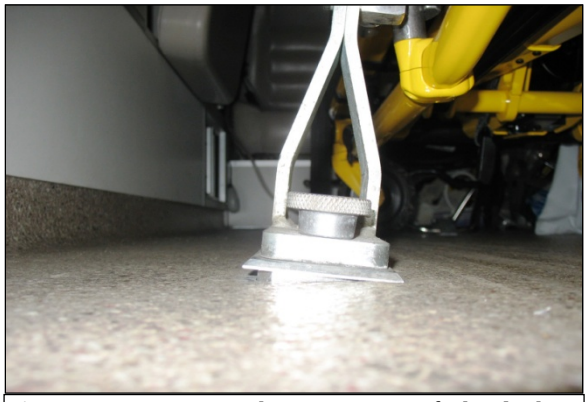

Figure 15: Post-crash orientation of the locking clamp mechanism within the Ford.

2012 FORD ECONOLINE 350 / MEDTEC TYPE III AMBULANCE OCCUPANTS

Driver Demographics

Age / Sex:	55 years / Female
Height:	Unknown
Weight:	Unknown
Eyewear:	No
Seat Type:	Box-mounted
Seat Track Position:	Rearmost
Manual Restraint Usage:	3-point lap and shoulder safety belt
Usage Source:	Vehicle inspection
Air Bag(s):	None deployed
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle with some assistance
Transport from Scene:	Ground ambulance to a local hospital
Medical Treatment:	Evaluated at local hospital and released from the emergency department in less than 24 hours

Driver Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
N/A	None	N/A	N/A	N/A

Source: Interview (Emergency services personnel)

Driver Kinematics

The 55-year-old female driver was positioned in the box-mounted seat. She had adjusted the seat base to its rearmost track position and slightly reclined the seat back. She also was restrained by the available 3-point lap and shoulder safety belt. Restraint usage was determined through a combination of the observations made by the SCI Investigator during the vehicle inspection and the statements of emergency response personnel.

As the driver operated the vehicle on the multi-lane roadway and ascended the hill, she began to succumb to the effects of her fatigue. She ultimately fell asleep and was unable to control the vehicle's directional movement, which enabled the Ford to drift left from its travel lanes. She presumably remained in a normal posture within the driver's seat.

The left front tire of the Ford traversed over the rumble strip of the east shoulder, resulting in a vibration and accompanying noise that awoke the driver. She provided braking and right steering input in an attempt to avoid a crash. The inertial forces of her braking input engaged the ELR, and her torso loaded the safety belt webbing as she initiated a forward trajectory. She remained in the driver's seat with her hands on the steering wheel and did not sustain injury as the vehicle maintained its forward movement and progressed through the first three frontal crash events.

As the vehicle traversed the embankment and initiated its right side-leading rollover sequence, the driver remained restrained within her seat. Forces associated with the Event 4 small sign impact were not of sufficient magnitude to affect her trajectory or induce injury. The driver then initiated a right lateral trajectory with respect to her seating orientation in response to the non-horizontal forces associated with the rollover. She again loaded the safety belt webbing and her right flank contacted and loaded the folding armrest mounted to the inboard aspect of the seat back. These kinematics did not result in injury to the driver.

The driver remained restrained by the 3-point lap and shoulder safety belt as the vehicle slid to final rest. Due to her positioning within the overturned vehicle, her body maintained a load on the safety belt's webbing such that she was unable to unbuckle the latch plate. Upon the arrival of emergency response personnel to the scene post-crash, her safety belt webbing was cut and she was assisted from the vehicle. A ground ambulance transported her to a local hospital, where she was evaluated and released without injury in less than 24 hours.

Front Right Passenger Demographics

Age / Sex:	22 years / Male
Height:	Unknown
Weight:	Unknown
Eyewear:	No
Seat Type:	Box-mounted
Seat Track Position:	Rearmost
Manual Restraint Usage:	No manual restraint used; 3-point lap and shoulder safety belt available
Usage Source:	Vehicle inspection; Ejection status; Injury outcome
Air Bag(s):	None deployed
Alcohol/Drug Data:	None
Egress from Vehicle:	Partially ejected through right front glazing opening, extricated by emergency response personnel
Transport from Scene:	Ground ambulance to a local hospital
Medical Treatment:	Pronounced deceased upon arrival at the emergency department

Front Right Passenger Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
N/A	Asphyxiation, NFS	020000.3	N/A	N/A

Source: Interview (Emergency services personnel); Official Records (Police Crash Report)

Front Right Passenger Kinematics

The 22-year-old male driver was positioned in the box-mounted seat with the seat track adjusted to a middle track position and the seat back reclined. He did not utilize the available 3-point lap and shoulder safety belt for manual restraint. The front right passenger's unrestrained status was determined through a combination of the observations made by the SCI Investigator during the vehicle inspection, his partial ejection during the crash sequence, and the statements of emergency response personnel. Based on the statements of the driver, the front right passenger was reclined in the seat in a sleeping position; however, the exact positioning of his head and extremities remains unknown. In any event, the front right passenger slept as the ambulance traveled on the multi-lane roadway. Due to his unrestrained status, he initiated an uncontrolled forward trajectory in response to the driver's abrupt braking application.

Based on discernible contact evidence located within the ambulance's cab, the front right passenger probably extended his arms forward in a bracing motion as the vehicle departed the roadway edge. He maintained a forward trajectory as the ambulance progressed through the first three impact events, contacting frontal components as follows: his knees contacted and loaded the lower instrument panel/knee bolster; his right hand contacted, loaded, and displaced the cover of the Heating, Ventilation, and Air Conditioning (HVAC) system vent within the top of the instrument panel (adjacent to the right A-pillar); his head and face contacted the windshield, leaving an oily skin transfer residue; and, finally, his right arm and shoulder contacted, loaded, and deformed the fascia and grab handle mounted to the interior aspect of the right A-pillar.

These contacts likely resulted in soft tissue injuries, including, but not limited to, minor abrasions and contusions. Forces associated with the Event 4 impact with the small sign were not of sufficient magnitude to affect the front right passenger's trajectory or induce further injury. The unrestrained male then initiated a right lateral trajectory in response to the rollover initiation. His right flank probably contacted the right front glazing, and his head contacted the right A-pillar. As the right plane of the vehicle contacted the asphalt surface of the roadway, the AS2 tempered right front glazing disintegrated. Due to his unrestrained status and right lateral trajectory, and in the absence of the glazing, the front right passenger was partially ejected from the vehicle. His head, upper torso, and upper extremities contacted the coarse surface of the asphalt roadway, inducing multiple unspecified soft tissue and musculoskeletal injuries as his body translated across the asphalt.

The front right passenger then became entrapped as his head, upper torso, and upper extremities were overrun by the vehicle as it slid to final rest. His ejected upper body became entrapped beneath the right front door and right front fender of the overturned vehicle. According to the occupant's medical records, he sustained numerous unspecified injuries as a result of the partial ejection and this entrapment, evidenced by the deformation of the exterior surfaces of the right front door and right front fender, as well as significant blood transfer on the surrounding vehicle surfaces. Efforts were made by first arriving emergency response personnel to remove the front right passenger from beneath the overturned vehicle. As minutes passed, his vital signs rapidly diminished and he soon lost consciousness. Fearing for his life safety, the emergency response personnel were forced to rapidly extract the front right passenger's body from beneath the overturned vehicle before they had been able to stabilize or mechanically lift it off him.

Immediate emergency medical care was initiated in an attempt to resuscitate the front right passenger as he was loaded into an awaiting ground ambulance and transported to a local hospital. Despite attempts to revive him, the 22-year-old male front right passenger was pronounced deceased upon arrival at the local hospital's emergency department. The Deputy Coroner's reported cause of death was positional asphyxiation. An autopsy was performed, though legal implications have prevented the release of its findings to the SCI Investigator. As such, exact injuries and their extent sustained by the male passenger remain unknown.

CRASH DIAGRAM